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ABSTRACT

A 1983 study examined the use of microcomputers in special education in 12 school districts. As a follow-up to that study, 3 years later, case studies were developed of 27 programs, including elementary/secondary school programs and educational or training centers for handicapped persons. Hypotheses of the research were organized into six major areas: organizational locus of control, collaboration in the use of microcomputers, balancing administrative and instructional applications, training for microcomputer use, emerging roles, and hardware and software issues. The follow-up study found that most of the earlier findings were valid, especially those related to organizational features that promote or inhibit computer use. Some evidence of improvement and progress were documented, such as increased levels of administrative involvement, expanded role of special education administrators in instructional technology decisions, availability of inservice training and technical assistance, and more diverse and sophisticated uses of computer-assisted instruction. Drill-and-practice applications remain the most common form of computer-assisted instruction, and the availability and distribution of resources is still an important concern. A general conclusion is offered that progress has been made but it will be many more years before new technologies are systematically integrated in the instruction of students with disabilities. (JDD)

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Case Study Findings on the Implementation of Microcomputers in Special Education

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A condensed version of this paper was presented at the Second Annual Technology and Media (TAM) Conference sponsored by the Council for Exceptional Children, Alexandria, VA, January 17, 1987.

Abstract

Findings are reviewed from two series of case studies on microcomputer implementation. The first series, conducted in 1983 for the U.S. Department of Education, included studies in 12 school districts distributed across 12 different states. The second series was conducted by graduate students at The Johns Hopkins University and included 27 case studies, predominantly in Maryland school districts.

The second series was designed to retest and expand upon findings from the first, to provide a comparison of results three years later in the evolution of computer applications in schools. The organization of the research in both studies was similar and focused on organizational issues: administration, collaboration, balancing resources, training, and emerging roles. The current study confirmed the validity of most of the findings from the earlier study, and added more detail to the constructs through independent evaluations of 36 qualitative hypotheses. Further, the current findings suggest that there has been improvement in some areas. A general conclusion is offered that progress has been made but it will be many more years before new technologies are systematically integrated in the instruction of handicapped students.

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Case Study Findings on the Implementation of Microcomputers in Special Education

This is an interesting time for educators. Many of us can remember being students when the only electric devices in the classroom were light bulbs and clocks. The last few decades have witnessed a series of technological innovations — most related to the conveyance of information — that have found their way into the schools: tape recorders, televisions, video recorders, and, lately, computers.

None of these technologies was originally designed or intended for educational use. Nevertheless, we have been quick to imagine their potential benefits. The introduction of computers is a case in point. Although early computers were targeted for military, scientific, business, and communications applications, by the early 1960's a growing number of educators were attempting to use them for instructional purposes. The term "computer-assisted instruction" (CAI) was in common usage by the early 1960's — although it competed for many years with other labels and acronyms, such as "computer-based instruction" (CBI) and "computer-aided learning" (CAL). Philadelphia (1966) and New York (1967) were the first two large school districts to implement CAI programs, while many universities had already (early sixties) initiated such efforts (Atkinson & Wilson, 1969).

By the seventies, special educators were also beginning to anticipate the value of computers for providing individualized instruction (Cartwright & Hall, 1974; Hallworth & Brebner, 1978). However, the real explosion of interest in CAI in special education resulted from the introduction of the microcomputer in the late seventies: this made CAI much more affordable and, therefore, feasible (Hannaford & Taber, 1982). By the early eighties, the revolution was truly underway. This was reflected in the enormous level of interest expressed at the first CEC-sponsored conference on computers in special education at Hartford, Connecticut in 1983. In recent years, expenditures of school funds to purchase hardware and software have accelerated at a rapid pace. Becker (1986) reported the number of computers for instructional use quadrupled from 250,000 in 1983 to more than one-million in 1985. An estimated 800 percent increase in microcomputer acquisitions by special educators occurred from 1982 to 1985 (Education Turnkey, 1983).

Although special educators <u>en masse</u> may appear to have embraced this technological innovation, hard data to support its efficacy is embarrassingly absent and the limited research on <u>how</u> computers are being used in special education is not encouraging. From 1982-1984, the Office of Special Education Programs (OSEP), U.S. Department of Education sponsored a study on "Microcomputers in the schools: Implementation in special education" (Hanley, <u>et al.</u>, 1983). The study documented many positive aspects of initial use of microcomputers in schools. However, a general finding was that in 12 school districts where microcomputers were used for instructional support, typical applications had limited applicability to educational goals:

> Observations of actual CAI use in special education classrooms, however, proved to be disappointing. The typical application used was "drill-and-practice" exercises or "educational games." Rarely was the CAI linked directly with students' individualized educational goals and objectives. Teachers often reported that they used the microcomputer as a "motivator" or to free up their own time to work individually with a student while other students were using the computers. These are legitimate uses of the technology, but they certainly don't represent the sort of potentially powerful applications that have been envisioned by education theorists. (Hanley, 1984, p. 36)

That conclusion was based on case studies conducted during the spring of 1983. The investigation concentrated on organizational issues associated with the introduction of technological innovations in schools. A premise for the studies was that decisionmaking at various levels of school organization would have effects upon the use of microcomputers in special education classrooms.

A few years can be a long time in a period of major technological transition. In preparing for the 1982-84 study, it was very difficult to even identify 12 school districts in the United States that had had sufficient experience with microcomputers -- one and one/half years -- to meet the planned research design requirements. Now, it would be more difficult to identify schools that have not attempted to use microcomputers.

Consequently, another series of case studies -- with the same focus on microcomputer implementation in special education -- was conducted during the spring of 1986. These studies aimed to re-examine the same general issues that were treated in the earlier investigation and, perhaps, to discover whether noticeable changes had occurred in the interim. This report is a summary of the new findings and a comparison of these results (1986) to the results obtained in 1983.

Method

The case studies were conducted by graduate students at The Johns Hopkins University, enrolled in the course "Computers in instruction: Supervision and organization," sponsored by the Special Education Technology Program at the University. Most of the students were teachers or educational administrators. The settings for the case studies included:

18 -- public or private elementary and/or secondary school programs

5 -- educational or training centers for handicapped persons

4 -- other settings (colleges, private sector)

Prior to the investigation, the students were instructed in case study methods (e.g., Yin, 1984) and were briefed on the findings from the earlier (1982-84) OSEP-sponsored research. Following class discussions, the students proposed and selected -- through concensus -- 36 specific qualitative hypotheses related to microcomputer implementation. The

hypotheses were directional statements of presumed causal relationships to be tested during the case studies.

Some other case study researchers, including Yin, have termed such causal statements "propositions," perhaps to differentiate from the traditional terminology used in stochastic and quantitative research designs. In contrast, this author asserts that the original term, hypothesis, is equally appropriate in qualitative methodologies, as long as the research design conforms to the a priori conventions of proactive investigation. Use of such traditional terminology emphasizes that proactive qualitative methods are congruent with scientific principals. The only inherent differences, between what are sometimes termed quantitative and qualitative investigations, relate to measurement and sampling issues, not to the essential scientific desiderata of a predictive epistomology. (Quantitative and qualitative studies can both veer from predictive designs when circumstances warrant. Examples of quantitative investigations that do not typically begin with hypotheses are general surveys, feasability studies, and exploratory or post hoc analyses. Similarly, qualitative studies that employ ethnographic approaches are usually reactive, rather than proactive, in design.)

Most of the hypotheses for the current investigation were based on the findings from the earlier Federal study, but some were drawn from recent literature and from informed opinion among the students. The hypotheses were organized in six major research areas:

(1) Organizational locus of control: centralization/decentralization

(2) Collaboration in the use of microcomputers

(3) Balancing administrative and instructional applications

(4) Training for microcomputer use

(5) Emerging roles (e.g., the coordinator function)

(6) Hardware and software issues

The target unit for each case study was the microcomputer system with which each student was most directly involved. This "system" was operationally defined as "a collection of microcomputer equipment shared by an identifiable set of users."

Each case study consisted of two stages: (1) descriptive and (2) analytical. In the descriptive stage, students were instructed to collect information linked to a series of questions covering varying aspects of microcomputer planning, implementation, training, and use. In the analytical phase, students were asked to review the descriptive information and evaluate system events and outcomes in relation to the hypotheses. Because many of the hypotheses were linked with the construct of growth in the microcomputer system, "growth" was operationally predefined to include:

- number of hours of microcomputer use
- number of microcomputer users (students and staff)

- number of different applications implemented, as well as diversity of applications
- number of microcomputers acquired and allocated
- number of groups (program areas within the school system, as well as outside groups, e.g., parents) actively involved in using or supporting the system

At the end of the semester, the students were required to submit their case studies, along with a completed checklist on the results for the 36 hypotheses. For each hypothesis, the students were required to specify one of three conditions:

(1) Supported in the case study -- evidence (interviews, observation, documentation) in the setting supported the hypothesis.

(2) Not supported in the case study -- evidence refuted the hypothesis, in whole or in part.

(3) Not applicable -- the particular hypothesis was not applicable to the setting; or sufficient evidence was not obtained to reach a conclusion of support or refutation.

These results were then tabulated, summarized, and reviewed.

In the analysis of results from multiple cases, a conclusion is fully supported only when evidence from all cases concurs with the hypothesis. When almost all cases concur, and the exceptions reflect distinctions that do not alter the essence of the statement, the hypothesis may be characterized as partially supported, with qualifications. However, when exceptions occur that in any way negate the assertion in the statement, the hypothesis must be declared "not supported." In this qualitative methodology, the test of the hypothesis is, essentially, an all-or-nothing proposition. The statement is true; or it is not true. This is a major distinction between the proactive, theory-driven qualitative method used here, and traditional quantitative methods that permit point estimation and partialling the components of variance.

As an empirical research method, case studies can be used to evaluate the semantic validity of hypotheses. Each case is, in essence, an experiment. When multiple cases support the hypothesis, the replications provide further evidence of its validity.

Frankly, it has been this author's experience that multiple case studies rarely provide full support for initial hypotheses. This actually represents one of the methodology's chief strengths: the ability that the information provides to assist in reassessing the hypothesis, and in identifying conditions that alter the anticipated effect. Over a series of case study investigations, it becomes possible to:

(1) discard hypotheses that have no merit;

(2) refine worthwhile hypotheses and generate new hypotheses to better approximate reality; and

(3) discover important intervening conditions that call for qualification of earlier hypotheses or introduction of new research questions and hypotheses.

All of these outcomes were experienced in this (1986) and in the earlier (1983) series of case study investigations on microcomputer implementation.

Results and Discussion

Because this research treated a broad spectrum of issue areas, the treatment of results in this section focuses separately on each of the six subcategories of investigation. In each area, a brief introduction to the issue, including review of findings from the 1982-84 study, is followed by discussion of the current findings. Table results from the current studies are included in Exhibit 1, following the narrative report.

1. Centralization and Decentralization

A major focus of the investigations was the issue of centralization-decentralization. Simply, this refers to the degree that decisions, regarding microcomputer use, are made by (a) administrators, centralized, or by (b) teachers, decentralized.

Most public school systems contain both centralized (district level, principals, "top-down") and decentralized (building level, teachers, "bottom-up") decisionmaking patterns. The introduction of technological innovations in instruction represents a situation where individuals — at different levels in the school's organizational hierarchy — may play important roles in initiation and adoption. In this context, microcomputer implementation may be very different from, say, adoption of larger computer systems.

> Freedom is fostered when the means of communication are dispersed, decentralized, and easily available, as are printing presses or microcomputers. Central control is more likely when the means of communication are concentrated, monopolized, and scarce, as are great networks. (de Sola Pool, 1983)

The cost of microcomputers may also be a factor that contributes to making them a decentralizing force in education. Many of the initial microcomputers in schools were acquired by individual teachers, using funds from external (to school) sources, including PTA's (Becker, 1984).

This "locus of control" issue is two-edged:

(1) The role and authority of individuals who make decisions about microcomputer adoption may affect the acceptance of the technology into the school system, as well as how the technology is used.

(2) The technology itself — microcomputers — may influence the way instructional services are delivered and, in some senses, weaken centralized control over educational practices.

1983 Findings. Based upon such premises, the 1982-84 study targeted levels of decisionmaking as a key issue. These were some of the key findings:

Presence of particular organizational patterns:

- No pattern of centralization or decentralization dominated the adoption or management of microcomputers across the 12 case studies.

- Decisionmaking patterns showed variation over time. Key personnel shifted in their roles: teachers (decentralized) often became official (administratively recognized) microcomputer coordinators.

- In six settings, district level personnel were extensively involved in all aspects of microcomputer implementation. In four districts, control was highly decentralized: building level and teaching staff introduced and managed the microcomputers. In two systems the pattern had shifted over time: one from centralized to decentralized, the other from decentralized to centralized.

Development of organizational locus of control:

- The typical centralized pattern developed when an administrator played an early role in adoption and implementation.

- A decentralized pattern emerged when district level staff were involved — if at all — only in approval or funding capacities; interest and expertise were concentrated at the school building and classroom (teachers and students) levels.

Effects of locus of control on implementation:

- Neither centralized nor decentralized patterns had clear advantages; growth (resources and numbers of users) and utilization (extent and diversity of applications) occurred with similar success in both types of sytems.

- Overly centralized policies could lead to problems, particularly allocation that disregarded the needs and interests of intended users; microcomputers were underutilized.

- Overly decentralized systems also experienced problems: growth and utilization were sporadic; isolated applications were vulnerable to staff turnover; equipment could become incompatible, limiting the sharing of resources; isolated applications were subject to redundancy and inefficiency.

Based on these findings, and upon other data related to communication and committee processes in the schools, the study concluded that effective

planning and implementation of microcomputers required collaboration by adminstrators and teachers. The presence of individuals with both knowledge, about microcomputers and educational needs, and authority, to commit school resources to technological innovations, was essential. The most successful programs were those in which administrators and teachers worked cooperatively to plan and manage microcomputer use.

1986 Findings. The tabular results from the current investigation are presented in Part 1 of Exhibit 1. Seven hypotheses were proposed for study.

1.a An increase in centralization will limit the number of students who use microcomputers: NOT SUPPORTED

Class discussions of centralization and decentralization often led to lively debates on the benefits and weaknesses of administrative control over microcomputer implementation decisions. The students in the course included both administrators and teachers; so the exchanges often reflected the different group perspectives on "who knows best" regarding computer use in education. Based on their own experiences, and supported in part by the earlier findings regarding "highly centralized" systems, some students felt that centralized implementation often produced systems that did not address the needs or interests of teachers. This hypothesis was one result of that context. The concept embodied was that administrative policies determining who should use the computers, and how they should be used, would restrict computer use and, therefore, result in less use.

However, after the data had been collected and the results analyzed in terms of each system's organizational structure and effects, the finding was counter to the expectation. The more centralized systems had higher levels of computer use, and systems that had undergone transitions in organizational climate for computer implementation showed higher utilization under more centralized control.

1.b Decentralization of instructional applications will encourage teachers to make more innovative use of the technology: NOT SUPPORTED/MIXED RESULTS

This hypothesis was another demonstration of the class attitude that centralized control would inhibit innovation and reduce creative application of microcomputers in instruction. In one sense the hypothesis would appear to be a truism — when teachers are directed they cannot (or should not) invent what they will do. Most of the students assumed, based on previous experiences in their settings, that reduced, or no, administrative direction fostered innovative and experimental use of the technology by teachers.

However, in a number of cases, the evidence did not support the expectation. The principal argument against it was that, in some cases, teachers were disinterested in computer applications and showed no initiative to use the technology. Administrative "encouragement" was necessary to foster teacher participation. Once teachers became involved, and became more knowledgeable, they often implemented innovative and useful applications. It was also noted that, "Administrators can be innovative too!" and examples were provided of centrally-initiated programs that fostered teacher innovation.

1.c Centralized special education administration is not heavily involved in initial use of microcomputers for instruction, but typically initiates administrative uses of microcomputers in special education: NOT SUPPORTED/MIXED RESULTS

This hypothesis was drawn directly from a principal finding in the 1982-84 study. Although a majority of the new cases provided evidence to support that conclusion in their settings, the multiple case analysis was that the hypothesis was not supported, because exceptions were documented.

In five of the school systems, and in two of the non-LEA centers for handicapped persons, special education administrators were involved in planning and implementation of instructional applications. If this finding here reflects a pattern in other settings as well, it may represent a major improvement in recent years (from 1983 when no involvement was noted).

1.d Successful (growing) microcomputer systems will become more centralized; less successful systems will become decentralized: PARTIALLY SUPPORTED

Although the majority of cases provided evidence to support this hypothesis, the exact wording of the statement may require some revision in future studies or applications. The students understood the intent of the hypothesis (discussed in class) and treated it on that basis.

Essentially, the phenomenon targeted here is time-oriented. It was first noted in the 1982-84 study and the current results partially confirmed it. A number of factors are involved. Instructional applications of microcomputers, particular in the early stages, have been typically initiated by teachers, often operating in isolation from adminstrators and, even, from other teachers — decentralized. Over time, as more teachers become involved, decentralized implementation often produces problems: such as incompatibility, vulnerability, sporadic use and underutilization, redundancy of efforts, etc. This attracts administrative attention. Administrators — sometimes in a sudden flurry of action — initiate controls to manage and direct microcomputer implementation. In brief, decentralized growth triggers administrative reaction and increased attempts to centralize control over the computers.

Alternatively, overly centralized systems may suffer from planning errors and lack of follow-through support (e.g., training, adequate resources, etc.). Computers and software may be purchased and allocated, but not used. Quite often, what happens in these instances is that, over time, individuals and small groups of teachers (decentralized) "adopt" the orphaned equipment and adapt it to their own interests and objectives. In these cases, less successful systems (centralized) enter a decentralized, renewal phase.

One final pattern that occurs is the increasing centralization -- and routinization — that takes place in highly successful systems. With proper organizational support and teacher participation, the system adopts more and more administrative accoutrements and functions: formal coordinator and "specialist" positions; policy and procedure plans and

documents; "advanced" inservice training programs, etc. Successful systems become even more centralized.

All of these patterns were documented in the case studies. In many cases, transitions back and forth from one to another pattern were noted, with expected results. Nevertheless, there were a few cases where evidence was marshalled to question the hypothesis.

In one school system, the student marked the hypothesis "No," but the rationale described a moot situation. There was a highly centralized district-level planning and implementation system for microcomputers. The district provided computers to the schools and directed staff on how they were to be used. However, the school staff disagreed with the district's objectives and developed their own agenda, one which eventually proved very successful. The principal at the school became very involved too, and formed a school-based committee to plan and manage their computers. In the case study, the student characterized the local school system of computers as "decentralized," which it was in relation to the district's implementation system. On that basis, a decentralized system was successful and growing. Alternatively, it could be argued that the "system" in this case was relatively independent of the district organization for microcomputer use. In that sense, the system had become centralized with the level of authority repositing in the local school administration, rather than at the district level.

1.e In successful (growing) systems, a computer coordinating committee/group will be present and will have these two characteristics: (1) participation by teachers and administration, and (2) limited membership (fewer than 10 persons): PARTIALLY SUPPORTED

This was supported in all but one of the school-based systems. The dissenter described a county-wide district with a large (46 members), representative committee, including one teacher from each school. The county's microcomputer system had experienced major growth. The case study, however, did not include enough information to qualify the hypothesis or to interpret or verify the factors associated with the stated success.

Among those who supported the hypothesis, however, many contrasted the effectiveness of different committee arrangements that had been used in their systems. Overall, they strongly supported the notions that (1) both administrative and teacher participation were necessary for most effective planning and management, and (2) the overall impact of committees appeared to be inversely correlated with their size. When committees became too large, they did not accomplish as much. Some noted, however, that large committees are sometimes useful to confirm and support new plans and approaches, or to ensure that a broad spectrum of perspectives are reflected in decisions.

In three of the non-LEA programs (centers), it was reported that there were no coordinating groups present and they were not required. Administrators limited most of their involvement to acquisition and allocation, and teachers/trainers were free to develop their own application approaches. There was, however, a good amount of informal sharing of information and ideas among staff.

Taken together, the results suggested that future tests of the hypothesis should incorporate restatement and, perhaps, more detailed investigation. It may be important, for example, to distinguish confirmatory from planning processes in technology committees, and to consider the overall size of the system that the committee represents.

1.f Centralization will increase microcomputer compatibility: SUPPORTED

There was no dissention on this point. All agreed that centralization of selection and acquisition of hardware decisions was the only way to ensure standardization and compatibility, to the degree those goals were appropriate for particular applications. This does not, however, imply that centralized systems will purchase only one type of hardware. In fact, centralized groups in many settings decided on different types of hardware/software for different settings and uses.

1.g If an administrator becomes more knowledgeable about microcomputer technology, the system will, over time, become more centralized: NOT SUPPORTED/MIXED RESULTS

The intent of this hypothesis was to identify administrators' knowledge and familiarity with microcomputer technology as a factor promoting higher levels of administrative involvement and system centralization. Although some felt the history of administrative involvement in their settings supported this conclusion, others disagreed.

In three school-based cases, all cited administrators who were "knowledgeable" about the technology but not interested in becoming more directly involved in planning and management of instructional applications. In two of these cases, the instructional systems were highly decentralized but administrators did purchase and acquire hardware as needed. In the third case, the teachers "compelled" the administrator to become more involved, because they wanted more coordinated planning and support. That system was becoming more centralized.

2. Collaboration

A key question for special educators is whether they should implement their own educational computer systems, or "latch on" to the hardware, software, and support systems developed for regular education. For one thing, sharing someone else's system would appear to be an economical approach, particularly if the special education program perceives its own funds as too limited to undertake expenditures for new equipment. On the other side, of course, are questions about how useful and appropriate the "borrowed" technology will be — in terms of the special needs of handicapped children.

These questions were examined in the 1982-84 case studies. It should be noted that all 12 school districts in that study were purposively selected because they included special education applications. Further, six of those districts were also selected because preliminary information suggested that there was collaboration between special and regular education in use of microcomputers. These selection factors — and similar biases of selection regarding the current sample — should be considered in

review of the findings. The case studies do not represent random samples from the universe of school districts.

1983 Findings. Interestingly, in the 12 original case studies all but one of the school districts demonstrated some levels of collaboration between special and regular education (only 6 were initially selected on that basis). The only case that did not involve collaboration was a special education administrative-only application of microcomputers. In that district, the system had been adopted solely for implementation of a computer-based IEP (individualized educational planning) system. The following is a summary of some of the key findings on collaboration that were obtained in the other 11 districts:

Adoption of microcomputers:

- Special education adoption of microcomputers for instructional applications was a "bottom-up" rather than "top-down" process. The first users of computers in special education were individual teachers, operating in relative isolation from district level administration.

- Following initial adoption, extensive collaboration developed between special and regular education teachers: in purchase and allocation of equipment; in coordination, scheduling, and management of the microcomputers; in training; and in software selection and use.

- Special education administrators sometimes collaborated with other administrators in purchase and allocation of equipment.

Collaborative patterns of use:

- Special and regular education teachers collaborated in decentralized (building and classroom level) decisions on coordination, training, and use (including software selection) of the microcomputers.

- Inservice training programs for regular and special educators were the same.

- Special education use of microcomputers emphasized computer-assisted instruction (CAI); regular education emphasized computer literacy and programming, but included some CAI.

- CAI applications in special education and regular education were very similar in terms of software and approaches used; however, regular education was more often restricted to "basic skills" vocational education, or younger (e.g., elementary level) students; special education CAI was implemented across all educational levels.

- Special and regular education teachers frequently shared hardware and software resources in the schools.

In general, the study found that sharing of microcomputers tended to increase the overall level of collaboration between regular and special education programs in the schools. In many cases, this increased self-esteem for special education students and staff. Sometimes they were the first to adopt microcomputers and to learn how to use them. They then introduced their nonhandicapped peers to the technology.

However, it was also noted that the most common applications of CAI in special education were drill-and-practice, educational games, and the use of microcomputers for rewards and reinforcers. CAI was not integrated with the curriculum and its relationship to IEP's was unclear. To some degree, the extensive collaboration and sharing could be attributed to the very simplicity of the instructional applications. Similarly, the only training received by most special education teachers was that offered by regular education, and it emphasized computer literacy. The study concluded that:

> Ultimately, special education administration may have to take a more active role in the planning and management of microcomputer systems to encourage more specialized use of this technology in programs for handicapped students. (Hanley, 1983, page 16)

1986 Findings. Eight hypotheses on the issue of collaboration were tested in the current study. The results are presented in Part 2 of Exhibit 1.

2.a Collaboration in use of microcomputers will result in more utilization (increased use): NOT SUPPORTED/MIXED RESULTS

In the majority of cases where the effects of collaboration could be evaluated, this hypothesis was supported. Nevertheless, there were two instances where local experience presented different results. In one case, the available computers (a lab setting) were already completely used and scheduled throughout the school day. As additional groups, such as special education, began to make use of the system, the schedule would be revised. As one groups' usage increased, others' would naturally decline — given the fixed resources. The overall use of the microcomputers was not affected.

A more interesting situation prevailed at the one other setting where the hypothesis did not hold. In that school, special and regular education both maintained their own computers. In addition, there was a third set of computers that could be shared by the two groups. What resulted was that both groups of users would always prefer to use their own equipment. They avoided the "sharable" equipment, because requesting and scheduling its use was a "hassle."

Future evaulations of this construct will require reformulation of hypotheses to satisfy the important qualifications identified in these two cases.

2.b When special and regular education share use of microcomputers, training does not emphasize those applications (such as individualization) that are particularly beneficial for handicapped children: NOT SUPPORTED

The evaluations of this hypothesis were actually very encouraging, insofar as they suggested that a change has occurred in recent years. In the 1982-84 study it was found that: (1) special educators received the same training as regular educators, and (2) the training emphasized computer literacy and programming. In the current case studies, eight cases reported joint training programs for regular and special educators. Three of these described inservice programs that included many of the features related to individualized instruction and CAI that are important to special education. Of equal interest, under the rating of "not applicable," many students reported training programs that were sponsored and provided by special education itself, and incorporated methods particularly useful and related to the needs of handicapped students.

2.c Collaborative decisions, regarding instructional use of microcomputers, occur at a decentralized level: SUPPORTED (in LEA programs)

The intent of this hypothesis was to measure the participation of administrators and teachers in actual management and implementation of instructional applications in classrooms: such as decisions on sharing software and hardware, arranging schedules for computer labs, etc. In all the cases that dealt with collaborative working arrangements in school programs, these processes were entirely decentralized; teachers made those decisions. It was only in non-LEA programs (1) and other settings (2) where administrators were directly involved in the day-to-day management of instructional applications of microcomputers.

2.d The only collaborative decisions made at an administrative or centralized level are those related to acquisition and allocation of equipment: PARTIALLY SUPPORTED (in LEA programs)

In school settings, nine out of ten cases of centralized collaborative decisionmaking related exclusively to purchasing and allocation of microcomputers. Notably, a few of the cases that were marked "not applicable" on this item indicated that all collaboration occurred at the decentralized level. No collaboration occurred between administrators of the different programs in those settings.

In the non-LEA programs for the handicapped, the students had been directed to examine the collaboration — or lack of it — between separate administrative groups if present. (The special/regular education dichotomy was not relevant.) In some of these centers, there were different organizational units that directed services for differing student/client populations. In two of those cases, a high degree of collaboration was reported across all levels of planning and decisionmaking related to computer use.

2.e In a school where both regular and special education use microcomputers for instructional applications, regular education will emphasize "computer literacy" or computer programming; special education will emphasize computer-assisted instruction (CAI): NOT SUPPORTED

In the limited number of settings where enough evidence was obtained to evaluate this hypothesis, the results ran counter to expectations. In one school, both groups emphasized "computer literacy." In the other schools, regular education either emphasized CAI (over literacy and

programming), or made both types of software available and left the selection to the individual discretion of teachers.

The importance of this finding is that, at least in this set of schools, regular education is clearly moving away from its earlier concentration on learning about computers, and toward instructional uses of computers. Many of the students noted this transition in their case study reports. They remarked that regular education staff felt that computer literacy was "old hat," and were now much more interested in CAI and "tool" applications of microcomputers.

2.f Collaboration between regular and special education leads to increased self-esteem for special education students and staff: SUPPORTED

Eight teachers whose computer systems involved sharing of resources between special and regular education affirmed this hypothesis. Many commented favorably upon this phenomenon and provided anecdotal descriptions of the improved relationships. In some cases special education students were the first in a school to use microcomputers; in others they used computers more regularly. In these situations, special education students and staff often served the role of "teaching" others how to use the equipment. One special education teacher wrote, "My students feel great when they can show off!" A regular education teacher commented, "Collaboration has helped reduce the segregation between the regular and special education departments."

2.g In a collaborative system, priority usage will be protected for those who purchased the equipment: NOT SUPPORTED/MIXED RESULTS

Although many cases supported this hypothesis, there were two instances where the relation between purchase and protected usage did not obtain. In one school many of the initial microcomputer purchases were made with Chapter 1 funds. However, these acquisitions were not followed up with inservice training or technical assistance support, and little use was made of them in Chapter 1 classes. Eventually, other teachers, including special education, learned about computer applications and the equipment became equally shared by all teachers and students in the school. In a second school, the principal stepped in and reassigned existing computers to classrooms with "the greatest need." One of these was provided to the resource room, although it had been originally purchased with regular education funds.

2.h Microcomputers that are used for "compensation" purposes (e.g., as adaptive devices, or sensory aids) in special education should not be included (shared) in a collaborative system: PARTIALLY SUPPORTED

There was some concern expressed in class by students who worked in school special education programs. Based upon the class readings and discussion, they felt that sharing of resources was, in general, a worthwhile idea. However, they were also concerned that computers that had been acquired to support compensatory and adaptive purposes in special education should not become part of a shared system of computers. In a sense, they wanted to qualify the expected positive results on collaboration, to ensure that administrators at some future date would not "steal" or force them to share computers acquired for these special uses.

The finding, in programs that used computers for such purposes, was that such equipment should not be shared. The two most common reasons given for this conclusion were:

(1) Computers dedicated to such uses were often modified and customized with special hardware. This could make operation of the equipment difficult for users accustomed to the standard hardware. Further, the nonfamiliar user could "mess it up."

(2) The handicapped students who needed these devices often depended upon them, for both instructional and communicative purposes. Their guaranteed access to the technology should be protected.

The one dissenter from this viewpoint was a teacher at an adult rehabilitation center. As with other students whose case settings only served handicapped persons, she was directed to treat the issue of collaboration as "between different administrative or programmatic groups" in the organization of the setting, if such groups operated independently.

The center in question served a very large client base of physically handicapped individuals. The center was also highly organized and structured, with a variety of different operational subunits. They made extensive use of many computer-assisted adaptive devices and aids. Nevertheless, resources were somewhat limited, given the large client base. Consequently, service providers in different organizational units regularly shared this equipment. In her case study, she stated that, "Service provision would be difficult and less than optimal, without collaborative sharing of adaptive equipment."

3. Balancing Administrative and Instructional Applications

During the 1960's and 1970's CAI was implemented on mainframe or minicomputer systems. In many settings — universities and school districts — the same computer used for CAI also supported other applications, including administrative. Early research on multiple usage of such systems suggested that the balance of resource availability, especially between instructional and administrative applications in educational systems, could become a contentious issue. Some authors (e.g., Naiman, 1982) claimed that growing administrative applications could eventually dominate the computer system, and displace instructional uses. Others (e.g., Yin, 1979; 1981) suggested a counter-influence: increased administrative use could lead to greater organizational support for computers in education; the instructional applications would benefit from larger computer systems, with improved capabilities, and better maintenance and support.

Microcomputers can support both administrative and instructional applications. Whether this debate was applicable to microcomputer systems was another implementation topic treated in the 1982-84 case studies.

1983 Findings. School systems that operated microcomputer-based instructional, administrative, or both types of applications were included in the study. In some cases, the systems began with only one type of

application but later expanded to use both types. This permitted an examination of the balance of applications over time -- to measure the relative growth and absorption of resources by each. The following is a summary of the findings:

Adoption patterns :

- In 9 of the 12 cases, microcomputers were adopted initially for instructional (only) applications. However, seven of the nine eventually added administrative applications.

- Two systems were planned as administrative and instructional from the outset. The remaining (12th) system was initiated as administrative only, and stayed that way.

- At the time of the case studies, the instructional-only (2) and the administrative-only (1) systems had shown the least expansion in terms of: numbers of users, diversity of applications, and growth of resources (hardware and software).

Patterns of use:

- In systems with "mixed" uses, the typical pattern over time was to allocate specific microcomputers, including newly acquired units, to specific uses. In a few instances where single units served both purposes, the balance of uses was carefully scheduled.

- In mixed systems, there seemed to be a sacrosanct understanding: administrators and teachers respected each other's needs and wanted to ensure mutual cooperation because it led to growth and success of the entire system.

- Administrative uses tended to grow gradually and were limited to fewer users. Consequently, administrative use did not race ahead of availability of microcomputers — particularly as administrators became more supportive of the technology and more interested in acquiring additional equipment.

The study concluded that both administrative and instructional uses could coexist favorably. In fact, presence of both types appeared mutually beneficial. Administrative applications seemed, in some cases, to present a signal of administrative support for the technology and encouraged teachers to become involved. Alternatively, some instructional users admitted they had consciously promoted and assisted administrative applications, to "co-opt" administrative support for their own efforts.

In a number of school districts, teachers contrasted microcomputer-based CAI with their previous mainframe-based experiences. They noted that, with mainframe and minicomputer systems, they had often been "bumped" for priority usage for administrative applications. Some said that this experience was an important factor in their initial desire to acquire microcomputers for CAI.

In reviewing the findings on this issue, the researchers suggested that an essential difference might be the cost of microcomputers:

> Mainframe and minicomputers represent a fairly fixed (and expensive) commodity. In contrast, when administrative needs for microcomputers increase, additional units can be added and the system as a whole can grow in an incremental fashion. (Hanley, 1983, page 12)

1986 Findings. Five hypotheses related to balancing administrative and instructional applications were tested in the current study. The results are presented in Part 3 of Exhibit 1.

3.a Increases in administrative applications will be coupled with increases in instructional applications as well: NOT SUPPORTED/MIXED RESULTS

A number of students did not examine this hypothesis because only one type of application (usually instructional) was implemented in their system. Among those who addressed the hypothesis, a majority cited evidence for growth in administrative applications coupled with increases in support and growth for instructional use. In many cases, particular examples were cited of positive alteration in administrative support for CAI, resulting from increased (or initial) administrative uses. These results conformed with the findings from the 1982-84 study.

However, in a few cases, the hypothesis was not supported. In one, it was found that previously planned administrative applications would exhaust too much of the limited computer resources, and the administrative applications were cancelled after their first year. In another case, computers — initially acquired for instructional applications — later became more used for administrative applications, particularly IEP development and record keeping. In part this transition occurred because of the special education teachers' dissatisfaction with the available CAI software. They decided that, until better software became available, their computers were best used for administrative applications.

3.b Use of only one type (brand) of microcomputer hardware will limit the diversity of applications: NOT SUPPORTED

During development of the hypotheses, many students proposed that some hardware (particularly Apple's) was more appropriate for instructional applications, and others (e.g., IBM PC and clones) for administrative applications. This hypothesis was designed to test that assumption.

In the case study investigations, many examples were presented of both types of applications being implemented successfully on a single brand or model of microcomputer. Students made the point the many of the best software products, both instructional and administrative, are now available for a variety of the more popular computer products: Apple, IBM, Commodore, Radio Shack, etc.

3.c Use of only one type (brand) of microcomputer hardware will increase the number of teachers who implement both instructional and administrative applications: NOT SUPPORTED

To some degree, this hypothesis represented an alternative hypothesis to 3.b (above). Some students felt, at the outset, that sufficient software was available to permit both general types of applications on any one of the popular hardware models. They reasoned, therefore, that the increased familiarity and expertise that results from having to learn only one operating system, would promote more teachers to attempt diverse operations. The corollary to this, of course, was that fewer teachers would implement both types of applications in systems where one computer was used for administrative, and a different computer for instructional applications.

As in 3.b, the results were very mixed. Examples of successful and unsuccessful efforts to combine types of applications were provided for both types of systems: one computer brand versus multiple computer brands. In effect, the brand of microcomputer(s) available did not appear to be a key determinant of the kinds of use teachers made of them. Other factors, such as teacher initiative, training, and available software, were much more important.

3.d If a special education administrator has not yet installed a computer-based IEP system, it will be reported that "one is planned in the future": NOT SUPPORTED/MIXED RESULTS

During initial class discussions, many students noted that one of the only interests of special education administrators in their school districts was for computer-based IEP systems. This hypothesis -- with some humor intended -- was designed simply to measure how many of the school systems in the investigation were currently "planning" such an implementation. It might be added that a number of the responses under "not applicable" represented school systems where computer-based IEP systems had been implemented.

3.e Both instructional and administrative applications will be more successful when separate microcomputers are allocated to each: PARTIALLY SUPPORTED

Note that the intent of this hypothesis referred to separate units, not necessarily to different brands of microcomputers. This hypothesis was also a restatement of one of the findings from the 1982-84 study.

A majority of the students found evidence to support this conclusion in their settings. Nevertheless, a few disagreed. One case was somewhat unusual. In that instance, the students used the computers to provide administrative services for the school: accounting and inventory records for the school store. The computers were the same ones they were also using for their instructional applications.

In the other two cases, limited resources required use of the same microcomputers for administrative and instructional applications. Through careful monitoring and management of the separate uses, both applications were viewed as successfully implemented. For future investigations, this hypothesis should be qualified to specify that when available resources are limited, the balance of applications should be carefully managed and scheduled.

4. Training for Microcomputer Use

It is axiomatic that teachers require some training or technical assistance to make knowledgeable use of a new instructional technology. Because most of those who are currently teaching received their formal (preservice) training in college, prior to the burgeoning interest in educational use of computers, the schools are now required to conduct inservice programs.

Assuming that personnel preparation would be an important factor -- to both growth and use of microcomputer systems -- the 1982-84 OSEP study examined the history, content, and results of training and technical assistance activities that had been conducted in the school districts.

1983 Findings. The school districts utilized a variety of approaches to prepare teachers to use microcomputers. These ranged from self-instruction and individualized technical assistance, in early stages of microcomputer adoptions, to large-scale, district-sponsored inservice training programs, common in districts where microcomputer use had become an important component of the instructional curriculum. Key findings were:

Patterns of training activities:

- Initial microcomputer users were self-taught, or they received instruction from external sources, such as colleges, consortia programs, and computer vendors.
- Early expansion of use to other teachers usually involved one-to-one technical assistance provided to new users by the original "zealots."
- In systems with major growth (units and users), available resources included:
  - district-wide group inservice training
  - building-level inservice training
  - user orientation workshops
  - parent workshops
  - training made available to educators from other school districts
  - classes provided by local colleges
  - school clubs and user groups
  - technical assistance from coordinators
- Group training opportunities were not essential during initial adoption stages, but were strongly associated with successful implementation of large, expanding systems of computer use.

- In some districts, the increasing availability of microcomputers outstripped opportunities for training and the microcomputers were underutilized.

Efficacy of training:

- Most administrators came to realize the importance of training. In many cases new users were not permitted access to the computers until they had successfully completed the training programs.

- Programming, such as in BASIC, was not an appropriate objective for introductory inservice training. Most teachers were not interested in learning how to program; they simply wanted to know how to operate the computers.

- Effective content for introductory training included:

  — microcomputer operations, features, and hardware

  — loading and running software programs

  — integrating computers with the curriculum

  — knowledge of available software and what it will do

  — how to review, select, and acquire additional software

  — saving programs and copying diskettes (assuming the material was public domain)

- Effective content for later (advanced) training included:

  — programming (e.g., BASIC)

  — authoring languages

  — word processing

  — computer-managed instruction (CMI)

  — other administrative and "tool" applications

- A recurring problem of district-sponsored training was the incompatibility of computer hardware and software, where individual schools and classrooms were using different products. A partial solution was provided through sponsorship of "user groups" which provided training tailored to particular hardware installations.

Training for special education teachers:

- In none of the cases was the training offered to special education teachers different from that offered to regular education teachers.

- The dominant CAI software — drill-and-practice and educational games -- was used similarly by special and regular educators; training requirements for both groups were the same.

- The few instances of specialized computer applications in special education — communication aides, hardware adaptations — were supported by individualized technical assistance activities, rather than by group training.

1986 Findings. Seven hypotheses were proposed and tested on the topic of training. The results are presented in Part 4 of Exhibit 1. A number of the hypotheses dealt with the content and format of "good" inservice training programs to prepare teachers to use microcomputers for instruction:

4.a Specific (rather than general) inservice training will increase the number of teachers using computers: PARTIALLY SUPPORTED

4.b Hands-on experience is an essential element of good inservice training: SUPPORTED

4.c Long-term, ongoing inservice training is better than short-term or periodic training. It will increase instructional use of microcomputers: SUPPORTED

4.f Training teachers how to program (e.g., in BASIC), as part of introductory training, is not a good idea (and does not lead to system growth): SUPPORTED

4.g A variety of training techniques (different methods, settings, subject, etc.) will result in increased applications of microcomputers: PARTIALLY SUPPORTED

The proposition of these five hypotheses reflected the students understanding and reading of materials on training (mostly the conjectures of authors) during the course. Hypothesis 4.f was also a retest of a finding from the 1982-84 study. In general the support for all of these training features was very strong.

Nevertheless, there were a few cases where evidence did not support the general findings. One advantage of the case study methodology is its ability to not only identify variation, but also obtain information about the variation. This information is useful toward refining the statement of hypotheses in future studies, as well as toward identifying other factors that may contribute to outcomes.

For example, two of the students who worked in non-LEA programs for the handicapped attributed little of the success in their settings to group inservice training programs. One felt that the training had been too "sporadic" and supported Hypothesis 4.c. But she noted that, although some of the training had been "specific" (Hypothesis 4.a), it had not led to increased teacher use of computers. In the other case, the student asserted that the inservice training at her center had been very "general," but effective. Both of these students felt that individualized technical

assistance had contributed more to the growth of computer applications at their settings.

One other student disagreed with Hypothesis 4.g. In her district, a variety of training approaches had been tried. But they had been too sporadic, too diffuse, and too short to have any impact on local practices.

4.d Growth of microcomputer systems is directly linked to availability of technical assistance and inservice training: PARTIALLY SUPPORTED

Only one student, a high school special education teacher, disagreed with Hypothesis 4.d. In her school district, all of the inservice training and technical assistance was "geared toward literacy and programming," and of little value to the special education teachers.

4.e The best trainers are those who were "self taught": NOT SUPPORTED

This hypothesis stemmed from the early experiences of many teachers, reflected in the 1982-84 study, that the initial trainers on microcomputer use were the original "zealots" who introduced the technology to schools. In 1986 the results indicated a movement away from that situation. Growing numbers of trainers now come from the ranks of those whose own introduction to computers came from previous inservice training programs, or from college or other external training providers.

5. Emerging Roles

When microcomputer use expands beyond initial stages of adoption by a few users, or when centralized administration implements a full-scale system of microcomputers for instruction, the need emerges for formal or informal coordination of the technology.

1983 Findings. In each of the school districts studied, an individual or group of individuals had responsibility for some or all of the following tasks:

- purchase and allocation of the microcomputers
- review, purchase, and distribution of software
- maintenance of a central file/catalog of software
- scheduling and planning computer use
- training and technical assistance to users

Some of the key findings on the coordinator role were:

Coordination groups and committees:

- Coordination groups were present in many, but not all, school districts. Their principal functions included planning, adoption, allocation, and management of microcomputers.

- Some coordination groups were formally constituted, but most were informal — even though informal groups often included district level (e.g., assistant superintendent) personnel.

- Most coordination groups relied heavily upon input from the early adopters and propagandists for microcomputers; these zealots represented a critical knowledge base for microcomputer applications.

Coordinator positions:

- Most of the school districts established formal coordinator positions at the district level. However, most of the active coordinators were school-based, teachers or consulting teachers who had been involved with computers from the start. Some of the school-based coordinators were formal designations, but most represented the voluntary assumption of those responsibilities, with encouragement from peers.

- School-based coordinators were expected to fulfill their other (pre-existing) instructional responsibilities. Coordination was considered, at most, to be a part-time role. In some cases, coordination was viewed simply as a related function of already established roles: special education consulting teacher, career counselor/coordinator, media specialist, etc.

Coordinator effects:

- The emergence of formal coordinator positions was characteristic of growing, successful microcomputer systems. Administrators seemed to recognize the importance of coordination to improve management of the systems and to reduce inefficiencies.

- Even in decentralized systems, where administrators were neither supportive nor interested in microcomputers, the teachers themselves tended to identify their own resource persons and rely on them for technical assistance, guidance, and management.

- Coordinators were the key developers and presenters of inservice training on microcomputers.

- Coordinators who had already had microcomputer experience in the classroom were perceived as the most effective by teachers.

1986 Findings. Four hypotheses related to coordinators were examined in the latest investigation. The results are presented in Part 5 of Exhibit 1.

5.a Growth of a microcomputer system increases the need for staff (teachers) to have release-time designated for computer activities, or for individuals to be specifically appointed as computer coordinators: PARTIALLY SUPPORTED

There was general confirmation for the conclusion, also reached in the 1982-84 study, that computer systems and their users needed individuals who

would manage the systems and provide technical support. The one dissenter, a high school vocational/marketing teacher, participated in a district-wide departmental advisory committee that coordinated use of microcomputers in his program. He was the only such teacher in his high school and he was quite comfortable to "coordinate" his own computer uses.

5.b More successful computer use will occur when the computer coordinator, in addition to other support services, provides individualized assistance to teachers -- for problem solving in classroom applications: PARTIALLY SUPPORTED

This hypothesis was developed from the students' perception that training, though important, was not enough; new users needed individualized technical assistance to make the best use of computers in instruction. Evidence that was utilized to support this hypothesis was drawn from two alternate conditions: settings where technical assistance was provided and contributed to better classroom computer use, and settings where technical assistance was not provided, and the growth of computer use suffered. The one setting where evidence did not support the hypothesis was a system where teachers were "encouraged to troubleshoot on their own as part of the learning process."

5.c A computer coordinator should have current, recent (within 2 years), or extensive (over 10 years) TEACHING experience. Without such experience, the coordinator (of instructional applications) will be ineffective: NOT SUPPORTED

This hypothesis was an extension of the 1983 finding that teachers perceived coordinators who had teaching experience as more effective. A majority of the students who evaluated the new hypothesis found evidence to support it in their systems. Nevertheless, those who disagreed provided equally compelling evidence from their own systems. In some cases, examples of excellent coordinators without recent teaching experience were cited, such as administrators and teacher consultants who had become very interested in computer applications. In one case, existence of a very poor coordinator with extensive teaching experience was provided.

5.d If a computer coordinator position is part-time, the coordinator should be released from about one-half his/her previous instructional responsibilities. If this is not done, the coordinator will either (1) be ineffective, or (2) suffer "burn-out" (burn-out usually leads, eventually, to some form of exit from the system): SUPPORTED

This was a very popular hypothesis when it was proposed and selected by the class, prior to conducting the case studies. Many of the students were serving coordination roles in their school systems, most of them on an informal basis. They complained heavily of the extra responsibilities and workload that was required, although they themselves had voluntarily assumed the role. Some bias in the judgement on this issue might be expected. Nevertheless, at least three of these students did exit from their school systems at the end of the semester.

6. Software and Hardware Issues

The 1982-1984 study did not address equipment resources as a separate major issue. Nevertheless, some findings were reported. For example, one sub-area of the investigation focused on the distribution of computer applications between large (e.g., mainframe, mini, or time-sharing) computer systems and microcomputers. It was noted that:

- Smaller administrative tasks, such as individual school enrollment and student records, mailing lists, communications, etc., were implemented on microcomputers and, in some cases, replaced similar applications that had previously been conducted on the larger systems.

- Similarly, in some districts instructional applications that had been implemented on larger computer systems had been switched to microcomputers. In addition to CAI, this included computer programming classes.

- Alternately, large-scale data reporting and analysis functions, such as payroll, district records, student grades and reports, were perceived by administrators and data processors as more appropriate for the larger computer systems.

Regarding microcomputer hardware and software, a very general and widespread finding from the early study was that many teachers were truly at a loss, in terms of the particular hardware and software products that should be acquired.

> When teachers start to consider CAI, the two most common questions they ask are, "What kind of microcomputer should I get?" and "What software should I buy?" (Hanley, 1984, p. 28)

> ...Many of these teachers, especially those who had not requested but had been given their microcomputers, reported that they were at a loss as to exactly what to do with the units. The teachers often asked members of the research teams whether they knew of any "good" software that could be obtained. They clearly were not in control of the technology, and they viewed it as a "black box" that could, perhaps, solve their needs if only they had better software. (p. 36)

1986 Findings. Five hypotheses were proposed dealing specifically with hardware and software issues. The results are presented in Part 6 of Exhibit 1.

6.a When software can be previewed by intended users, more appropriate software will be purchased: SUPPORTED

All of the students who collected evidence on software selection and acquisition processes agreed that this was true. This conclusion has also been substantiated in other studies, including a recent survey of teacher experiences with software review and purchasing procedures (Morariu, Coulson, & Malouf, 1986). Since the great majority of educational software producers (84% in a recent survey by Salpeter, 1987) have review policies,

there would be appear to be no good reason for educators not to insist on preview before purchase.

6.b Use of CAI will increase as the quality, range, and content of available software increases: PARTIALLY SUPPORTED

The students claimed — in their comments on this hypothesis — that availability of "good" software is still one of the major factors affecting CAI use. The more software that teachers had, and the more directly related that software was to their teaching objectives, the more the microcomputers were used for CAI. The one student who disagreed with the hypothesis claimed that in her setting the lack of other supports, e.g., training, would continue to restrict the value of even the best software.

6.c Availability of different hardware systems will increase use (productivity) of microcomputers: NOT SUPPORTED

In posing this hypothesis, many students felt that some brands and models of microcomputers were more appropriate than others for particular applications. For example, some felt the IBM PC's and clones were most useful for administrative and "tool" applications; Apple's were better for CAI.

In the case studies, many students (10) could not address the issue, because their system was based on only one type of microcomputer. Of those who did address the question, about half felt that the added difficulty of having to learn two (or more) different operating systems mitigated against any possible advantage that could have resulted from the assumed superiority of one product over another for different applications.

6.d Proper planning, before purchase, will enhance microcomputer use, after implementation: PARTIALLY SUPPORTED

The intention of this hypothesis was that administrators/coordinators should determine how computers will be used, before they commit to large purchases of hardware and software. The one student who indicated that the hypothesis was not supported at her setting noted that they had "plenty of planning, but not enough follow-up!"

6.e The most common forms of CAI in use will be "drill-and-practice" and educational games: NOT SUPPORTED/MIXED RESULTS

Although this was generally true in the school-based settings (15 out of 17 responding), there were notable deviations. One elementary school program had implemented a variety of applications, including tutorial and "problem solving — using LOGO," as well as drill-and-practice. A high school special education teacher reported that they had not implemented very much of it, but what they were doing was tutorial, using an authoring system.

The major contrast to this hypothesis, however, occurred in the "Non-LEA programs for the handicapped." Four of these (5) refuted the statement, and their case studies demonstrated a wide range of instructional applications, including tutorial, simulation, and extensive use of adaptive devices and special peripheral equipment.

Synthesis and Summary

Two general themes were evident in the current case studies:

(1) Most of the earlier (1983) findings, especially those related to organizational features that promote or inhibit computer use, continued to be valid.

(2) In some of the areas where particular weaknesses were noted in 1983, some evidence of improvement and progress were documented in the current case studies.

Organizational dynamics within school districts exert a strong influence on implementation and utilization of computers for instruction. The current studies reemphasized the importance of cooperation and interaction between administrators and teachers. Although neither series of investigations was necessarily representative in a statistical sense, the current case studies documented higher levels of administrative involvement and also suggested that special education administrators may be beginning to play a more active role in instructional technology decisions.

Previous concerns may have lessened that collaboration between special and education programs would diminish the particular value of computer use for handicapped students, due to regular education's earlier emphasis on computer literacy and programming. The current evidence indicates that regular education administrators and staff have broadened their technology interests, to include computer-assisted instruction and tool applications. Collaborative use of computers still appears, however, to be largely decentralized, with teachers in school buildings sharing their resources on an informal basis.

The availability and distribution of resources is still an important concern, although control over hardware and software seems to devolve to those who make the most effective use of the available equipment, rather than to those who initially purchased it. Further, the growth and success of administrative and instructional applications depend upon individuals in each school who actively promote and pursue them, rather than to any inherent utilities of the hardware and software.

Inservice training and technical assistance are critical, particularly to expand computer use beyond the small groups of zealots who originally embraced new technologies. There has been growth and a wider cross-section of staff are now capable and willing to coordinate and assist other teachers. However, increasing computer use places additional demands upon those who provide coordination and assistance.

Drill-and-practice applications remain the most common CAI in special education, but there is some evidence that more diverse and sophisticated uses are increasing, particularly in non-LEA programs for handicapped persons. Overall, availability of software is expressed as a greater need, partly because the specific brand of hardware is not viewed as important. More involvement by teachers in planning and previewing software may lead to better instructional applications of computers in classrooms and resource rooms.

On the whole, the current investigations presented a fairly positive picture of growth and increasing acceptance of new technologies.for instruction. The bandwagon mentality that characterized the first stage of microcomputer introduction in the early eighties may now be giving way to a more reasoned perspective. Large-scale technological change will require time, patience, and a gradual evolution in our understanding of new instructional processes and how they come about.

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 1: Organizational Issues, Centralization/Decentralization

Hypothesis		SUPPORT Yes	No	N/A
1.a	An increase in centralization will limit the number of students who use microcomputers.	4	16	7
	1. Public and private el/sec school systems	4	8	6
	2. Non-LEA programs for the handicapped	0	4	1
	3. Other setting (colleges, private sector)	0	4	0
1.b	Decentralization of instructional applications will encourage teachers to make more innovative use of the technology.	15	6	6
	1. Public and private el/sec school systems	10	4	4
	2. Non-LEA programs for the handicapped	4	1	0
	3. Other setting (colleges, private sector)	1	1	2
1.c	Centralized special education administration is not heavily involved in initial use of microcomputers for instruction, but typically initiates administrative uses of microcomputers in special education.	12	8	7
	1. Public and private el/sec school systems	9	5	4
	2. Non-LEA programs for the handicapped	3	2	0
	3. Other setting (colleges, private sector)	0	1	3
1.d	Successful (growing) microcomputer systems will become more centralized; less successful systems will become more decentralized.	19	3	5
	1. Public and private el/sec school systems	12	1	5
	2. Non-LEA programs for the handicapped	5	0	0
	3. Other setting (colleges, private sector)	2	2	0
1.e	In successful (growing) systems, a computer coordinating committee/group will be present and will have these two characteristics: (1) participation by teachers and administration, and (2) limited membership (fewer than 10 persons).	20	4	3
	1. Public and private el/sec school systems	15	1	2
	2. Non-LEA programs for the handicapped	2	3	0
	3. Other setting (colleges, private sector)	3	0	1
1.f	Centralization will increase microcomputer compatability.	21	0	6
	1. Public and private el/sec school systems	13	0	5
	2. Non-LEA programs for the handicapped	4	0	1
	3. Other setting (colleges, private sector)	4	0	0

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 1. Organizational Issues, Centralization/Decentralization (continued)

Hypothesis	SUPPORT Yes	No	N/A
1.g If an administrator becomes more knowledgeable about microcomputer technology, the system will, over time, become more centralized.	11	4	12
1. Public and private el/sec school systems	4	3	11
2. Non-LEA programs for the handicapped	4	0	1
3. Other setting (colleges, private sector)	3	1	0

Part 2: Collaboration in Use of Microcomputers

Hypothesis	SUPPORT Yes	No	N/A
2.a Collaboration in use of microcomputers will result in more utilization (increased USE).	18	2	7
1. Public and private el/sec school systems	12	1	5
2. Non-LEA programs for the handicapped	2	1	2
3. Other setting (colleges, private sector)	4	0	0
2.b When special education and regular education share use of microcomputers, training does not emphasize those applications (such as individualization) that are particularly beneficial for handicapped children.	6	3	18
1. Public and private el/sec school systems	5	3	10
2. Non-LEA programs for the handicapped	0	0	5
3. Other setting (colleges, private sector)	1	0	3
2.c Collaborative decisions, regarding instructional use of microcomputers, occur at a decentralized level.	14	2	11
1. Public and private el/sec school systems	11	0	7
2. Non-LEA programs for the handicapped	1	1	3
3. Other setting (colleges, private sector)	2	1	1
2.d The only collaborative decisions made at an administrative or centralized level are those related to acquisition and allocation of equipment.	11	6	10
1. Public and private el/sec school systems	9	1	8
2. Non-LEA programs for the handicapped	1	2	2
3. Other setting (colleges, private sector)	1	3	0

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 2: Collaboration in Use of Microcomputers (continued)

Hypothesis	SUPPORT Yes	No	N/A
2.e In a school where both regular and special education use microcomputers for instructional applications, regular education will emphasize "computer literacy" or computer programming; special education will emphasize computer-assisted instruction (CAI).	2	9	16
1. Public and private el/sec school systems	2	7	9
2. Non-LEA programs for the handicapped	0	1	4
3. Other setting (colleges, private sector)	0	1	3
2.f Collaboration between regular and special education leads to increased self-esteem for special education students and staff.	10	0	17
1. Public and private el/sec school systems	8	0	10
2. Non-LEA programs for the handicapped	0	0	5
3. Other setting (colleges, private sector)	2	0	2
2.g In a collaborative system, priority usage will be protected for those who purchased the equipment.	12	2	13
1. Public and private el/sec school systems	6	2	10
2. Non-LEA programs for the handicapped	2	0	3
3. Other setting (colleges, private sector)	4	0	0
2.h Microcomputers that are used for "compensation" purposes (e.g., as "adaptive" devices, or sensory aids) in special education should not be included (shared) in a collaborative system.	8	1	18
1. Public and private el/sec school systems	5	0	13
2. Non-LEA programs for the handicapped	2	1	2
3. Other setting (colleges, private sector)	1	0	3

Part 3: Balancing Administrative and Instructional Applications

Hypothesis	SUPPORT Yes	No	N/A
3.a Increases in administrative applications will be coupled with increases in instructional applications as well.	15	4	8
1. Public and private el/sec school systems	10	2	6
2. Non-LEA programs for the handicapped	3	1	1
3. Other setting (colleges, private sector)	2	1	1

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 3: Balancing Administrative and Instructional Applications (continued)

Hypothesis	SUPPORT Yes	No	N/A
3.b Use of only one type (brand) of microcomputer hardware will limit the diversity of applications.	13	12	2
1. Public and private el/sec school systems	7	9	2
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	1	3	0
3.c Use of only one type (brand) of microcomputer hardware will increase the number of teachers who implement both instructional and administrative applications.	11	13	3
1. Public and private el/sec school systems	8	8	2
2. Non-LEA programs for the handicapped	2	3	0
3. Other setting (colleges, private sector)	1	2	1
3.d If a special education administrator has not yet installed a computer-based IEP system, it will be reported that "one is planned in the future."	12	5	10
1. Public and private el/sec school systems	10	4	4
2. Non-LEA programs for the handicapped	1	1	3
3. Other setting (colleges, private sector)	1	0	3
3.e Both instructional and administrative applications will be more successful when separate microcomputers are allocated to each.	18	3	6
1. Public and private el/sec school systems	10	2	6
2. Non-LEA programs for the handicapped	4	1	0
3. Other setting (colleges, private sector)	4	0	0

Part 4: Training for Microcomputer Use

Hypothesis	SUPPORT Yes	No	N/A
4.a Specific (rather than general) inservice training will increase the number of teachers using computers.	23	3	1
1. Public and private el/sec school systems	17	0	1
2. Non-LEA programs for the handicapped	3	2	0
3. Other setting (colleges, private sector)	3	1	0

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 4: Training for Microcomputer Use (continued)

Hypothesis	SUPPORT Yes	No	N/A
4.b Hands-on experience is an essential element of good inservice training.	27	0	0
1. Public and private el/sec school systems	18	0	0
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	4	0	0
4.c Long-term, ongoing inservice training is better than short-term or periodic training. It will increase instructional use of microcomputers.	20	0	7
1. Public and private el/sec school systems	11	0	7
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	4	0	0
4.d Growth of microcomputer systems is directly linked to availability of technical assistance and inservice training.	24	1	2
1. Public and private el/sec school systems	15	1	2
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	4	0	0
4.e The best trainers are those who were "self-taught".	7	11	9
1. Public and private el/sec school systems	4	5	9
2. Non-LEA programs for the handicapped	3	2	0
3. Other setting (colleges, private sector)	0	4	0
4.f Training teachers how to program (e.g., in BASIC), as part of introductory training, is not a good idea (does not lead to system growth).	21	0	6
1. Public and private el/sec school systems	14	0	4
2. Non-LEA programs for the handicapped	3	0	2
3. Other setting (colleges, private sector)	4	0	0
4.g A variety of training techniques (different methods, settings, subject, etc.) will result in increased applications of microcomputers.	21	1	5
1. Public and private el/sec school systems	12	1	5
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	4	0	0

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 5: Emerging Roles

Hypothesis		SUPPORT Yes	No	N/A
5.a	Growth of a microcomputer system increases the need for staff (teachers) to have release-time designated for computer activities, or for individuals to be specifically appointed as computer coordinators.	25	1	1
	1. Public and private el/sec school systems	17	1	0
	2. Non-LEA programs for the handicapped	4	0	1
	3. Other setting (colleges, private sector)	4	0	0
5.b	More successful computer use will occur when the computer coordinator, in addition to other support services, provides individualized assistance to teachers — for problem-solving in classroom applications.	22	1	4
	1. Public and private el/sec school systems	14	0	4
	2. Non-LEA programs for the handicapped	4	1	0
	3. Other setting (colleges, private sector)	4	0	0
5.c	A computer coordinator should have current, recent (within 2 years), or extensive (over 10 years) TEACHING experience. Without such experience, the coordinator (of instructional applications) will be ineffective.	13	7	7
	1. Public and private el/sec school systems	10	3	5
	2. Non-LEA programs for the handicapped	2	2	1
	3. Other setting (colleges, private sector)	1	2	1
5.d	If a computer coordinator position is part-time, the coordinator should be released from about one-half his/her previous instructional responsibilities. If this is not done, the coordinator will either (1) be ineffective, or (2) suffer "burn-out" (burn-out usually leads, eventually, to some form of exit from the system).	18	0	9
	1. Public and private el/sec school systems	12	0	6
	2. Non-LEA programs for the handicapped	2	0	3
	3. Other setting (colleges, private sector)	4	0	0

EXHIBIT 1: HYPOTHESIS TABULATIONS

Part 6: Software and Hardware Issues

Hypothesis	SUPPORT Yes	No	N/A
6.a When software can be previewed by intended users, more appropriate software will be purchased.	24	0	3
1. Public and private el/sec school systems	17	0	1
2. Non-LEA programs for the handicapped	4	0	1
3. Other setting (colleges, private sector)	3	0	1
6.b Use of CAI will increase as the quality, range, and content of available software increases.	22	2	3
1. Public and private el/sec school systems	15	1	2
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	2	1	1
6.c Availability of different hardware systems will increase use (productivity) of microcomputers.	9	8	10
1. Public and private el/sec school systems	6	3	9
2. Non-LEA programs for the handicapped	2	3	0
3. Other setting (colleges, private sector)	1	2	1
6.d Proper planning, before purchase, will enhance microcomputer use, after implementation.	25	1	1
1. Public and private el/sec school systems	16	1	1
2. Non-LEA programs for the handicapped	5	0	0
3. Other setting (colleges, private sector)	4	0	0
6.e The most common forms of CAI in use will be "drill-and-practice" and educational games.	18	8	1
1. Public and private el/sec school systems	15	2	1
2. Non-LEA programs for the handicapped	1	4	0
3. Other setting (colleges, private sector)	2	2	0

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